



Part Two:

Soil Moisture and Temperature

Introduction

This section introduces material common to three standard protocols and a fourth optional protocol for advanced students. The protocols are all related to soil moisture and temperature. To begin, students will use a simple procedure to measure soil moisture. They will weigh a soil sample, dry it out, and weigh it again. The difference in weight is the moisture in the soil that was dried out. An optional protocol for advanced students involves the use of gypsum blocks and a soil moisture meter to take daily readings of soil water content. Two new protocols measure other important soil properties. The rate water flows into the soil (infiltration) is measured using two concentric cans. Soil temperature is measured using a short dial or digital probe thermometer.

Study Site for the Investigation

Generally, the Soil Moisture Study Site should be in the open, with no canopy overhead, and within 100 m of the Atmosphere Study Site or a supplemental Atmosphere Study Site with at least a rain gauge. Depending upon which sampling strategy is used (see below) you may need an area 10 m in diameter characterized by low slopes, homogeneous soil characteristics, natural soil moisture, and uniform sunlight conditions. It is useful to make soil characterization, soil temperature, and infiltration measurements within the same homogeneous 10 m area so that they can all be related to the soil moisture measurements. Some schools may choose a larger site with an area 10 m by 60 m which meets most of the criteria summarized above but which can include some variations in slope and other characteristics.

Your Soil Moisture Study Site(s) should be:

Unirrigated. Since we want to investigate the soil's response to the sun and natural precipitation, it is important that your site be unirrigated.

Uniform. Soil moisture can vary significantly across short distances. The challenge is to find an

area where the soil moisture is representative of your site. Look for a relatively flat site that has uniform soil properties and vegetation.

Relatively undisturbed. Sample soils at least three meters from buildings, roads, paths, playing fields, and other sites where the soil may be compacted or heavily disturbed by human activity.

Safe for digging. Check with local utility companies and site maintenance staff to ensure that you do not dig into or disturb a utility cable, buried pipe, or sprinkler irrigation system. You will not be digging below one meter.

Frequency

Measure soil moisture at regular intervals, twelve times each year. Select a period during which you would normally expect the soil at your study site to undergo significant moisture changes. Observations of soil moisture should not be made when the ground is frozen. Weekly measurements during the beginning of your dry season will help predict plant growth. Monthly observations throughout the year or measurements every three weeks during a nine or ten month school year will provide insight into important seasonal variations.

Take your observations at the same time every day, and avoid early morning when dew is present. Soil moisture changes slowly so that the time of your observations is not critical. Taking all the measurements at one time of day ensures that any small daily cycles, particularly in near surface soil moisture, will not confuse your weekly to monthly observations.

Measure soil temperature once per week and on the same date and at the same location as your soil moisture measurements. If your school is not measuring soil moisture, take soil temperature measurements within 10 m of your Atmosphere Study Site following the sampling strategy for temperature given under *Collecting in a Star Pattern*. Weekly temperature measurements should be taken within one hour of local solar

noon. Every three months, preferably during March, June, September and December, make soil temperature measurements every two to three hours during the daytime for two consecutive days to determine the diurnal temperature variation at your site.

Measure soil infiltration three times during the course of your annual soil moisture investigation, ideally around the beginning, middle and end of that observation period, and on the same day you sample soil moisture. If you measure soil moisture monthly, measure infiltration seasonally.

Sampling Strategies and Site Layout

Materials and Tools

GLOBE Science Notebooks and pencils
Compass and 50 meter tape
25 cm ruler, meter stick
Trowel

Collecting in a Star Pattern (6 containers)

Measurements are taken in a star-shaped pattern with samples collected each time at different locations on the star. Soil moisture samples will

come from a depth of 0 to 5 cm and at a depth of 10 cm. Each time, three samples should be acquired (1 primary sample and 2 additional samples within 25 cm) for quality control purposes. Take three soil temperature measurements at depths of 5 cm and 10 cm within 25 cm of the sampling point following the *Soil Temperature Protocol*.

Layout a simple star two meters in diameter by using a meter stick and compass to locate four points approximately one meter north, south, east and west from a central reference marker. Locate four more points halfway between these points along an imaginary circle connecting these points. You now have eight points on your star. Four more points should be located 25 cm from the reference marker along the north - south, east - west lines. Every year, select a new reference marker within ten meters of the previous year's star and repeat this pattern. It should take less than ten minutes to collect your six soil moisture samples using a trowel.

Collecting Along a Transect (13 containers, 50 m tape or cord marked every 5 m)

Students with access to an open, natural field are encouraged to take measurements along a transect. The soil samples will come from the top 5 cm of soil. Each time, thirteen samples will be acquired - ten regular samples along the transect and one triplicate sample (1 sample along the transect plus 2 additional samples within 25 cm of the first) for quality control purposes.

Layout your transect along a straight line 50 meters long across an open area within 100 m of a rain gauge, if possible. Measure soil moisture every five meters along this line. Place a permanent flag or marker at the ends of your transect. Use the knotted cord or a measuring tape to locate these sampling points. Orientation does not matter, but please record the orientation as a comment on the Study Site Work Sheet and report it on the Study Site Definition Data Entry Sheet. The next time you sample the transect, shift each of your data collection points 25 cm to avoid the previously disturbed area. It might take an hour to layout and sample a transect, especially if students are sharing equipment and observing other surface and soil characteristics.

Figure SOIL-P-10: "Star" Sampling Pattern

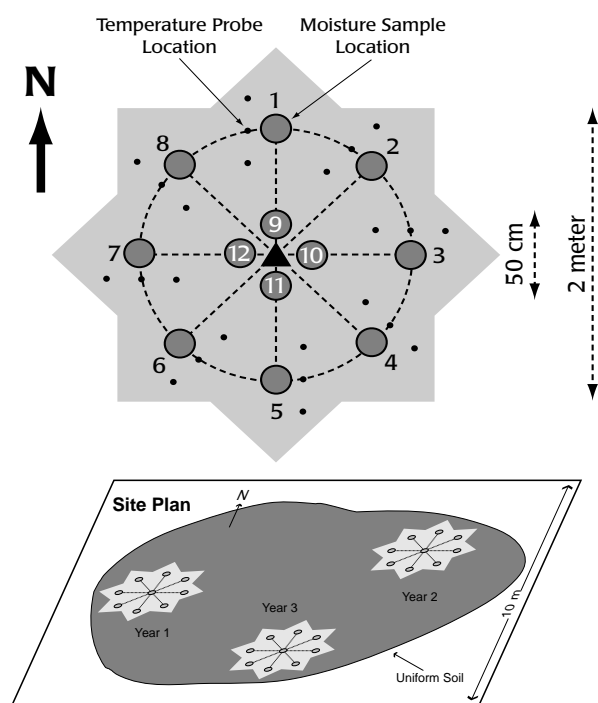
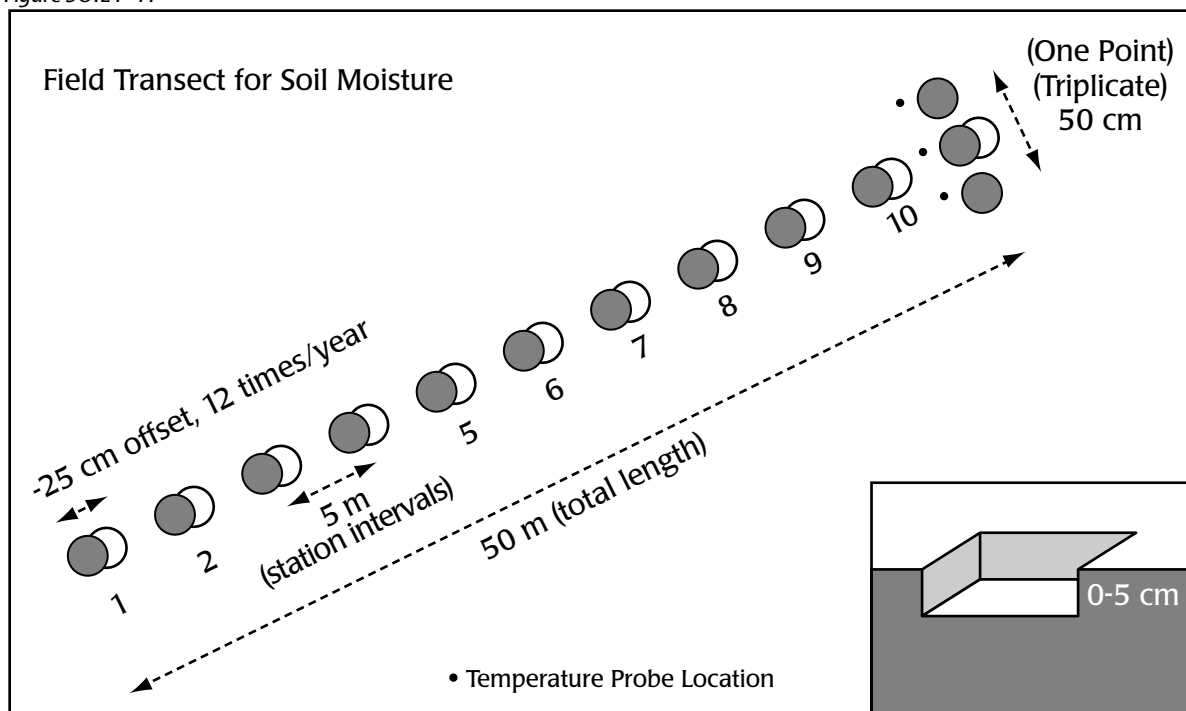


Figure SOIL-P-11



Collecting at Different Depths (5 containers, auger)

Students take measurements in a star-shaped pattern, collecting samples each time at different locations on the star. Soil samples from all five depths will be collected from the same hole. Use a trowel to sample from the top 5 cm and an auger to sample at the four deeper depths (10, 30, 60, 90 cm). Unlike the previous two sampling strategies that are designed strictly for open areas, this one can be done in the open or under a canopy, depending upon what data comparisons

you wish to make (e.g. comparing soil moisture to evaporation or

tree growth). Layout a star pattern as described above to locate the sampling holes around a central reference marker. If your auger strikes an obstruction, offset by 25 cm and try again. Depending upon conditions, a hole 90 cm deep might take 30 minutes to auger and sample.

Advanced students in areas where soils are not strongly acidic are encouraged to consider using the *Optional Gypsum Block Soil Moisture Protocol*.

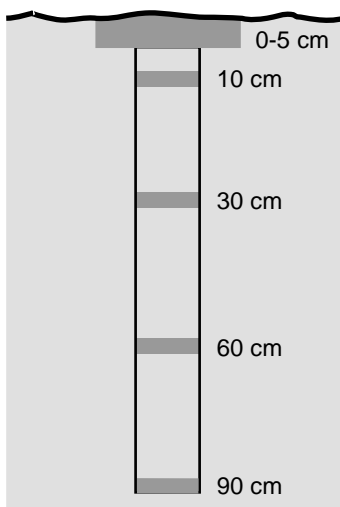


Figure SOIL-P-12